Malathion Technical Briefing

U.S. Environmental Protection Agency
Office of Pesticide Programs

November 9, 2000

Introduction and Overview

Lois Rossi, Director
Special Review and Reregistration Division

Overview of Day's Activities

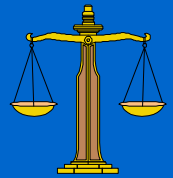
- Legal framework and regulatory history
- Provide usage profiles
- Present risk assessments
- Questions and comments

Goals of Meeting

- Provide an understanding of EPA's risk assessments
- Answer your questions
- Identify risks of concern
- Begin risk mitigation dialog

Legal Context

- FQPA amendments to FIFRA required
  - Reassessment of all existing tolerances
  - Aggregate assessments
  - Safety factor for children
  - Cumulative assessments



EPA Implementation of FQPA

- Formation of Tolerance Reassessment Advisory Committee (TRAC)
- Development of science policies
- Development of pilot process for public participation
- Focus on organophosphates (OPs)

TRAC Pilot OP Review Process

- Phase 1 (30 days)
  - Registrant “error only” review
- Phase 2 (up to 30 days)
  - EPA considers registrants’ comments
- Phase 3 (60 days)
  - Public comment on preliminary risk assessment

TRAC Pilot OP Review Process

- Phase 4 (90 days)
  - EPA revises risk assessments, holds public meetings/technical briefings
- **Phase 5 (60 days)**
  - **EPA solicits risk management ideas**
- Phase 6 (up to 60 days)
  - EPA develops final risk management strategies

Regulatory History and Comments

Patricia Moe, Chemical Review Manager
Special Review and Reregistration Division

Regulatory History

- First registered in 1956 by American Cyanamid Company
- Registrants
  - Cheminova Agro A/S (primary data provider)
  - Griffin LLC
  - Prentiss Inc.
  - Verdant Brands Inc.
  - AMVAC Chemical Corp.
  - Gowan Co.
  - Drexel Chemical Co.
  - Platte Chemical Co. Inc.
  - Micro-Flo Co.

❖ Registration Standards issued in February, 1988

Phase 3 - Public Comment

- Approximately 100 comments were received from
  - Registrants
  - Environmental/consumer organizations
  - Commodity associations
  - Government agencies
  - Growers
  - Lawn care professionals
  - Private citizens

Phase 4 - Revise Risk Assessments

- Changes to the risk assessment
  - Revised agricultural transfer coefficients
  - Updated percent crop treated and monitoring data
  - Updated incidence report
  - Corrected errors and provided clarification in the ecological assessment

Phase 5

- Technical briefing
- Revised risk assessments available in public docket and on the internet
- Begin 60-day public participation period
- Public input on risk management

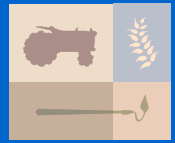
Summary of Unsupported Uses

- The following uses are not being supported. Therefore, they were not considered in this risk assessment:
  - All pet uses
  - All livestock uses
  - All indoor uses (except for some stored commodities and storage facilities, and mushroom houses)
  - All greenhouse uses
  - All open-forest land uses
  - All seed treatments

Summary of Unsupported Uses

- Almonds (including hulls and shells)
- Cranberries
- Filberts
- Peanuts (including forage, hay, storage & storage facilities)
- Peavines (including hay)
- Safflower seed
- Soybeans (including hay and forage)
- Sugar beets
- Sunflower seed
- Tobacco
- Treated raisin trays
- All pressurized can formulations

Use Profile



Tim Kiely, Economist
Biological & Economic Analysis Division

Use Profile

- Organophosphate insecticide/acaricide
- Currently not a restricted-use pesticide
- Five formulations of end-use products
  - 235 active labels

Use Profile

- End-use products
  - Dust
  - Soluble concentrate/ liquid
  - Emulsifiable concentrate
  - Liquid ready-to-use
  - Wettable powder

❖ Application methods (list is only representative)

- Soil treatment (banded, rodded, in-furrow, mound, etc.)
- Spray (low volume, high volume, surface, foliar, etc.)

Use Profile

- Application equipment (list is only representative)
  - Airblast sprayer
  - Groundboom sprayer
  - Aerial sprayer
  - Hand-held sprayers (such as low- and high-pressure handwand, hose-end sprayer)
  - Shaker can
  - Fogger
- 340 use sites

Use Profile - Agricultural Uses

- Field Crops: Corn, sorghum, oats, rye, barley, rice, hops, wheat, alfalfa, cotton, rice
- Vegetables: Bulb (e.g., onions), cole (e.g., broccoli), leafy (e.g., celery), cucurbit (e.g., cucumber), legume (e.g., beans), fruiting (e.g., tomatoes), other (e.g., asparagus)
- Fruit: Citrus (e.g., oranges), pome (e.g., apples), stone (e.g., peaches), berries (e.g., blueberries), other (e.g., grapes)
- Tree Nuts: pecans, walnuts, chestnuts, macadamias

Use Profile - Other Uses

- Residential
  - Lawn and garden
  - Ornamentals
- Public health (e.g., mosquito control)
- USDA cotton boll weevil eradication program
- Quarantine
  - CA, FL section 18 for exotic fruit fly control on fruits and vegetables

Use Profile

- Average agricultural use rates
  - Most acreage treated at a rate of 1 lb/acre or less per application
  - Most acreage treated at 5 lbs/acre or less per year

Use Profile

- Typical usage (pounds applied)
  - Estimated 16.7 million pounds active ingredient (lbs ai) applied annually to all sites

    Largest agricultural market is cotton (67% of total pounds applied)

    No other crop accounts for >2% of total pounds applied

    Largest non-agricultural markets are homeowner insect control (9%), mosquito control (5%) and exotic fruit fly control (3%)

Use Profile

- Typical usage (pounds active ingredient applied)
  - Agricultural sites

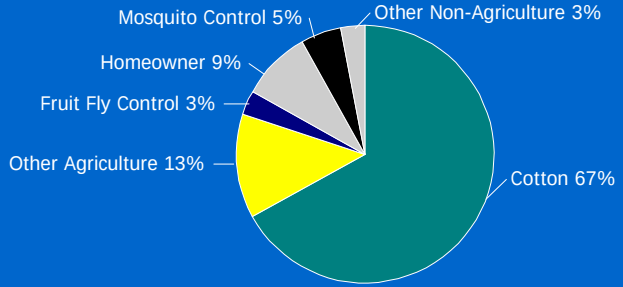
    13.3 million lbs ai applied

  - Non-agricultural sites

    3.4 million lbs ai applied

Use Profile

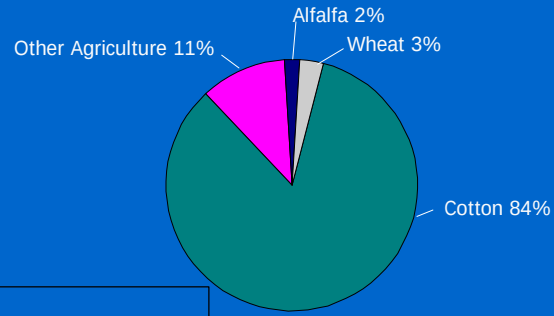
Malathion Usage As a Percent of Total Pounds Applied In U.S. Agricultural and Non-Agricultural Markets



Source: EPA Data
Estimated 16.7million lbs applied

Use Profile

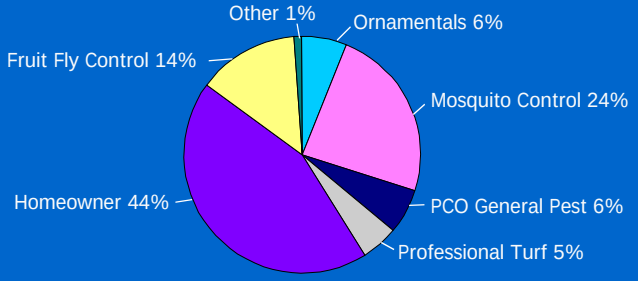
Malathion Usage As a Percent of Total Pounds Applied in U.S. Agriculture



Source: EPA Data
Estimated 13.3 million lbs applied

Use Profile

Malathion Usage As a Percent of Total Pounds Applied In U.S. Non-Agricultural Markets



Source: EPA Data
Estimated 3.4 million lbs applied

Use Profile

- Agricultural acres treated
  - Estimated 3.1 million acres treated annually

    Cotton: 72% of total agricultural acres treated

    Alfalfa: 8% of total agricultural acres treated

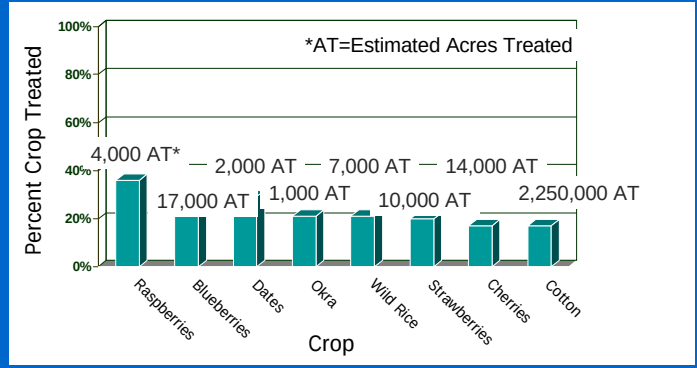
    No other crop accounts for >3% of total agricultural acres treated

Use Profile

- Major uses by estimated percent crop treated
  - Eight crops with >10% crop treated (see Figure)
    - Raspberries, blueberries, dates, okra, wild rice, strawberries, cherries, cotton
  - Alfalfa: 1% crop treated (240,000 acres treated)
  - 34% of wheat treated post-harvest as stored grain

Use Profile

Major Crop Use by Percent Crop Treated



Source: EPA Data

Use Profile

- Major uses by estimated percent crop treated
  - Eight crops with >10% crop treated (see Figure)
    Raspberries, blueberries, dates, okra, wild rice, strawberries, cherries, cotton
  - Alfalfa: 1% crop treated (240,000 acres treated)
  - 34% of wheat treated post-harvest as stored grain

Use Profile

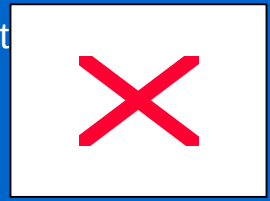
- Sources of use data
  - USDA/NASS
  - National Center for Food and Agricultural Policy
  - California Department of Pesticide Regulation
  - Commodity/user groups
  - US EPA proprietary databases
- Website
  - www.epa.gov/trac/science

Human Health Risk Assessment

Presented by: Paula A. Deschamp, Risk Assessor
Jack Arthur, Environmental Scientist
Brian Dementi, Toxicologist
Health Effects Division

The Risk Assessment Team

- Paula A. Deschamp, Risk Assessor
- Jack Arthur, Environmental Scientist
- Brian Dementi, Toxicologist
- William O. Smith, Chemist
- Richard Griffin, Biologist



Hazard Identification and Dietary Risk Assessment

Paula A. Deschamp, Risk Assessor
Health Effects Division

Risk Assessment Components

- Dietary
  - Food and drinking water
- Non-occupational (residential/recreational)
  - Handlers and postapplication
- Aggregate
  - Food, drinking water, non-occupational
- Occupational (agricultural workers)
  - Handlers and postapplication

Hazard Identification Process

- Review/evaluate all toxicology studies
- Consider all adverse effects seen – species/sex/route/duration
- Select studies appropriate for route and duration of exposure scenario

Hazard Identification Process

- Consider all adverse effects seen
  - Non-cancer
  - Cancer
- Select critical toxic effect (endpoint)
- Select the lowest dose for the effect
- Selected dose/endpoint would be protective of all potential adverse effects

Malathion Hazard Concerns

- Non-cancer effects
  - Cholinesterase inhibition
  - Reduced body weight gains
  - Nasal lesions from inhalation studies
- Cancer potential
  - Liver, nasal tissues & other organs

Cancer Hazard Potential

- 1990 - Reviewed five National Cancer Institute (NCI) cancer studies
- Concluded the studies showed no clear evidence of carcinogenicity
- Required new cancer data

Cancer Hazard Potential

- Mid-1990's - Reviewed all available data
  - Old and new carcinogenicity studies
  - Other relevant information
- Results of malathion studies
  - Liver tumors in both sexes of mice
  - Nasal and liver tumors in female rats
- Results of malaoxon studies
  - No evidence of cancer in mice or rats

Weight of Evidence Determination

February 2000

- Classified by the OPP's Cancer Assessment Review Committee as a "likely human carcinogen"
  - Liver tumors in mice and rats
  - Rare nasal tumors in female rats (treatment related)
  - Possible weak mutagenicity support for cancer
- Recommended Q_1* quantification for human risk characterization
- Other tumors not considered treatment related

What Changed

- Agency issued Phase 1 preliminary risk assessment for registrant error-only comment
- Registrant reevaluation of rat liver data for existing cancer study
  - Agency agreed with the conclusions of the reevaluation
- Unknown significance of oral and nasal tumors in the female rat
- Mutagenicity literature articles

Weight of Evidence Determination

April 2000

- OPP's Cancer Assessment Review Committee classified malathion as "Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential"
  - Benign liver tumors only at a dose causing death in rats and at toxic doses in mice
  - Few but rare oral and nasal tumors of unknown significance
  - No mutagenicity support for cancer
- Quantification for human cancer risk characterization is not used with a suggestive classification

FIFRA Scientific Advisory Panel

- Agency's April 2000 determination was brought to Science Advisory Panel for review (August 2000)
- Final report expected in November 2000
- Agency will consider the Panel's recommendations in final risk mitigation measures

Hazard Conclusions

- No cancer hazard was identified for risk characterization
- Non-cancer hazards were identified for quantitative risk characterization

Effect Levels

- Lowest Observed Adverse Effect Level = LOAEL
  - The lowest dose at which an adverse health effect is seen (mg per kg body weight per day)
- No Observed Adverse Effect Level = NOAEL
  - The dose at which no adverse health effect is seen (mg per kg body weight per day)
  - This dose is less than the LOAEL

Uncertainty and Safety Factors

10X :	Interspecies Extrapolation
10X:	Intraspecies Variation
3X to 10X:	Modifying Factor
1X to 10X:	FQPA Safety Factor
100X to 10,000X:	Total Uncertainty and Safety Factors for Risk Assessment

Expression of Dietary Risk

$$RfD = \frac{NOAEL}{UF}$$

RfD = Reference Dose
PAD = Population Adjusted Dose
(risk is not of concern when it is less than 100% of the PAD

$$PAD = \frac{RfD}{FQPA\ Safety\ Factor}$$

$$\%\ PAD = \frac{Exposure}{PAD} \times 100$$

Expression of Occupational & Residential Risk

$$MOE = \frac{NOAEL}{Exposure}$$

MOE: Margin of Exposure

The larger the MOE, the lesser the concern

FQPA Safety Factor Assessment

- Complete toxicity database
- No developmental effects in fetuses below maternally-toxic doses
- No increased sensitivity in pups when compared to adults
- No neuropathology

FQPA Safety Factor Assessment

- Exposure from food, water, and residential pathways unlikely to be underestimated
- Based on the above weight-of-evidence considerations the FQPA Safety Factor was reduced for malathion risk assessments

Dietary Risk Assessments

Dietary Risk = Hazard x Dietary Exposure

where:

Dietary Exposure = Consumption x Residue

Acute Hazard (Toxicity)

Studies	Weight of evidence using two rabbit developmental studies
Endpoint	Maternal toxicity characterized by decreased body weight gain
NOAEL	50 mg/kg/day
Notes	Toxicological endpoints attributable to a single oral dose were not observed in dams at 50 mg/kg/day

Chronic Hazard (Toxicity)

Studies	Combined chronic toxicity/ carcinogenicity in the rat
Endpoint	Plasma cholinesterase inhibition
NOAEL	2.4 mg/kg/day
LOAEL	29 mg/kg/day
Notes	Endpoint reflects the potential toxicity that could result from long-term exposure to malathion

Dietary Risk Assessments

Acute

- Reflects one-day dietary exposures to pesticide residues

Chronic

- Reflects lifetime (long-term) exposures to pesticide residues

Exposure - Consumption

- USDA's Continuing Survey of Food Intake by Individuals (CSFII) 1989-92 Data
  - Surveys designed to measure what Americans eat and drink
  - Represents the general population and subpopulations including infants and children

Exposure - Residue

Tier	Residue Data Used
1	Tolerance Level Residues
2	Field Trial Residues
3	Monitoring Data USDA PDP Data FDA Data

Exposure - Residue

Acute

- Tier 1
- Tolerance level
- 100% crop treated

Chronic

- Tier 3
- Monitoring data
- Usage estimates

Chronic Exposure - Residue Data

- Monitoring Data
  - USDA's Pesticide Data Program (PDP) data
    - Prepared as in the home (e.g., washing and peeling)
    - Statistically designed for dietary risk assessment
    - Used for ~40% of commodities
  - FDA Surveillance Monitoring Data
    - Designed for tolerance enforcement
    - Large number of samples and types of food
    - Used for ~44% of commodities

Chronic Exposure - Residue Data

- Tolerance level residues
  - Reassessed tolerance values
    - Used for 7% of commodities
- Field trial data
  - Data used in establishing EPA tolerance levels
    - Used for ~9% of commodities

Expression of Dietary Risk

$$RfD = \frac{NOAEL}{UF}$$

RfD = Reference Dose
PAD = Population Adjusted Dose
(risk is not of concern when it is less than 100% of the PAD

$$PAD = \frac{RfD}{FQPA\ Safety\ Factor}$$

$$\%\ PAD = \frac{Exposure}{PAD} \times 100$$

Uncertainty Factors

10X: Interspecies Extrapolation

10X: Intraspecies Variation

1X: FQPA Safety Factor

Total UF Applied

General Population:	100
Infants and Children:	100
Females of Child Bearing Age:	100

Population Adjusted Dose (PAD)

Acute PAD (aPAD)

- General population
- Children and females of the child bearing age

$$\text{RfD} = \frac{50 \text{ mg/kg/day}}{100 \text{ UF}} = 0.5 \text{ mg/kg/day}$$

$$\text{aPAD} = \frac{0.5 \text{ mg/kg/day}}{1 \text{ FQPA SF}} = 0.5 \text{ mg/kg/day}$$

Acute Risk Estimates

Population	Percent of aPAD* (95th Percentile Exposure)
U.S. Population	20
Infants	35
Children 1-6	38
Females	13

*aPAD = 0.5 mg/kg/day

Population Adjusted Dose (PAD)

Chronic PAD (cPAD)

- General population
- Children and females of childbearing age

$$\text{RfD} = \frac{2.4 \text{ mg/kg/day}}{100 \text{ UF}} = 0.024 \text{ mg/kg/day}$$

$$\text{cPAD} = \frac{0.024 \text{ mg/kg/day}}{1 \text{ FQPA SF}} = 0.024 \text{ mg/kg/day}$$

Chronic Risk Estimates

Population	Percent of cPAD*
U.S. Population	0.8
Infants	0.7
Children 1-6	1.6
Females	0.7

*cPAD = 0.024 mg/kg/day

Drinking Water Risk Assessment

- Conducted because of use pattern and environmental fate profile
- Based on screening-level model estimates for surface water and monitoring data for groundwater
- Where malaoxon parameters are unknown, malathion and malaoxon are assumed to have similar fate parameters

Drinking Water Risk Assessment

- Groundwater
  - Monitoring Data

    Pesticides in Ground Water Database 1971-1991, National Summary

    Detections in 12 samples from >3000 wells

    Conservative Ground Water Concentrations

    – 3.1 ppb for malathion and 3.1 ppb for malaoxon

Drinking Water Risk Assessment

- Groundwater
  - Conservative value of 6 ppb for malathion and malaoxon combined
  - Acute and chronic exposure
  - Based on monitoring data from >3000 wells

    19 States

    All geographic regions

Drinking Water Risk Assessment

- Surface water
  - Modeling data

    Tier 1 GENEEC

    Crops Modeled
    - Cotton and citrus

    Model Estimated Environmental Concentrations (EECs) are
    - Acute: 226 ppb malathion and 96 ppb malaoxon
    - Chronic: 7 ppb malathion and 25 ppb malaoxon

Drinking Water Risk Assessment

- Surface water
  - 322 ppb malathion and malaoxon combined used for acute
  - 32 ppb malathion and malaoxon combined used for chronic
  - Based on modeling data

Drinking Water Risk Assessment

- Allowable Exposure – Food Exposure = Water Exposure
- Drinking Water Level of Comparison (DWLOC) – surrogate measure of drinking water exposure
- Compare DWLOC to EEC
- No concern if EECs less than DWLOC
- Potential concern if EECs greater than DWLOC

Drinking Water Risk Assessment

Acute Results*

- There are no acute concerns for residues in drinking water

Source	Malathion / malaoxon	DWLOC
Groundwater monitoring data	6 ppb	3,100 ppb
Surface water modeling data	322 ppb	3,100 ppb

*Results for most highly exposed subpopulation – children 1-6

Drinking Water Risk Assessment

Chronic Results*

- There are no chronic concerns for residues in drinking water

Source	Malathion / malaoxon	DWLOC
Ground water Monitoring data	6 ppb	240 ppb
Surface water modeling data	32 ppb	240 ppb

*Results for most highly exposed subpopulation – children 1-6

Occupational & Residential Risk Assessment

- Duration of exposure
  - Short-term
  - Intermediate-term
  - Long-term
- Route of exposure
  - Dermal
  - Inhalation
  - Incidental oral

Occupational & Residential Risk Assessment

Dermal

- Short- and intermediate-term exposure

Studies	21-day dermal in the rat
Endpoint	Plasma, RBC, brain cholinesterase inhibition
NOAEL	50 mg/kg/day
LOAEL	300 mg/kg/day
Target MOE	100

Occupational & Residential Risk Assessment

Inhalation

- Short- and intermediate-term exposure

Studies	Two inhalation studies (two-week range finding and 90-day inhalation study)
Endpoint	Histopathlogy in respiratory epithelium (nasal lesions)
NOAEL	Not established
LOAEL	25.8 mg/kg/day
Target MOE	1000 (occupational and residential)

Occupational & Residential Risk Assessment

Inhalation

- Short- and intermediate-term exposure

Studies	Two inhalation studies (two-week range finding and 90-day inhalation study)
Endpoint	Plasma and RBC cholinesterase inhibition
NOAEL	25.8 mg/kg/day
LOAEL	116.1 mg/kg/day
Target MOE	100 (occupational and residential)

Occupational & Residential Risk Assessments

Jack Arthur, Environmental Scientist
Health Effects Division

What Was Assessed

- Occupational Exposure (exposure through work)
  - Handlers

    Workers who mix, load or apply pesticides. Includes certified pest control operators (PCO), farmers, and growers

  - Postapplication Workers

    Workers who enter treated sites to perform work activities, including pruning, thinning, hoeing, scouting and harvesting

What Was Assessed

- Residential Exposure (non-occupational exposure to general public)
  - Handlers: private citizens who mix, load or apply pesticides around their homes and residences
  - Postapplication: private citizens who contact treated sites in residential or public areas

    Includes bystander exposure from agricultural and public health uses

What Was Assessed

- Public health mosquito control
  - Ultra-low volume malathion formulation applied with aerial and ground-based fogger (residential postapplication)
- USDA Boll Weevil Eradication Program
  - Ultra-low volume malathion formulation applied by fixed-wing aircraft (residential postapplication)

Occupational Handler Assessment

- Handler risk assessment factors
  - Activity (e.g., mixing/loading and application of pesticide)
  - Formulation (e.g., wettable powder, emulsifiable concentrate)
  - Application equipment (e.g., groundboom, fixed-wing aircraft)
  - Amount of pesticide handled (i.e., application rate for major crop groups, number of hours worked, number of acres treated)
  - Level of protection (PPE, Clothing, Engineering Controls)
  - Toxicity endpoint and uncertainty factors

Occupational Handler Assessment

- Scenarios Assessed
  - Various combinations of these factors (i.e., formulations, equipment types, application rates for major representative crop groupings) result in 72 handler scenarios in the assessment

Occupational Handler Assessment

- Data Sources
  - Labels
  - EPA guidances and policies
  - Use information
  - Growers, registrants, pesticide applicators
  - Pesticide Handlers Exposure Database (PHED)

Occupational Handler Assessment

- Exposure and Risk Calculations

$$\text{Dose (mg/kg/day)} = \frac{\text{(Unit exposure) x (Use rate) x (Area treated per day)}}{\text{Body weight}}$$

$$\text{MOE} = \frac{\text{NOAEL (mg/kg/day)}}{\text{Dose (mg/kg/day)}}$$

NOTE: The target MOE is 100

Occupational Handler Assessment

- Summary of MOEs for handler scenarios
  - With Baseline Clothing: 30% of scenarios reached the target MOEs at baseline (i.e., long-sleeved shirt, long pants, shoes and socks)
  - With PPE: 50% of scenarios required some form of personal protective equipment (PPE) or clothing to reach the target MOEs (i.e., coveralls, chemical-resistant gloves, respirators)
  - With Engineering Controls: 20% of scenarios required some form of engineering control to reach target MOEs (i.e., closed mixing/loading systems, closed cab)
- 100% are able to reach target MOE

Occupational Postapplication Assessment

- Postapplication exposure factors
  - Application rate
  - Activity (e.g., pruning, hand-harvesting, mechanical harvesting)
  - Crop grouping (e.g., citrus, root vegetable)
  - Transferable residues (i.e., amount of pesticide residue that is available to "come off" when contacted by a worker)

Occupational Postapplication Assessment

- Postapplication exposure factors
  - Transfer coefficient (i.e., indicator of amount of foliar contact by a worker, and may be different for each crop grouping and activity)
  - Residue dissipation rate
  - Toxicity endpoint and uncertainty factors

Occupational Postapplication Assessment

- Various combinations of certain factors (i.e., activities, application rates, crop groups) result in 29 postapplication scenarios in the assessment.
- Example:

Crop Group	Representative Crops	Applic. Rate (lb ai/A)	Activity	Transfer Coefficient (cm^2/hr)
Vegetable, fruiting	eggplant, peppers, tomato	3.43	hand-harvesting, tying, pruning, thinning	1000
Vegetable, cucurbit	cucumbers, squash, pumpkin	1.88	hand-harvesting, pruning, thinning	2500
			scouting, irrigating	500

Occupational Postapplication Assessment

- Data sources
  - Labels
  - Agricultural Reentry Task Force
  - Turf Transferable Residue (TTR) Study

Occupational Postapplication Assessment

- Turf study results
  - Results used for turf, as well as all agricultural crops
  - Residue half-life in turf study was approximately 13 hours (or 46% dissipation of residues)
- In the risk assessments:
  - At 24 hours, approximately 72% dissipation
  - 72% dissipation rate per day used for turf calculations (TTR)
  - 46% dissipation rate per day use for all other crops (DFR)

Occupational Postapplication Assessment

- Exposure and Risk Calculations

$$\text{Dose (mg/kg/day)} = \frac{\text{TTR or DFR } (\mu g/cm^2) \times \text{CF } (0.001 \text{ mg}/\mu g) \times \text{Tc (cm2/hr)} \times \text{ED (hr/day)}}{\text{BW (kg)}}$$

$$\text{MOE} = \frac{\text{NOAEL (mg/kg/day)}}{\text{Dose (mg/kg/day)}}$$

NOTE: Restricted Entry Interval (REI) is the length of time (often in days) following treatment when the calculated MOE $\geq$ 100

Occupational Postapplication Assessment

- Summary of Postapplication Risk
  - Twenty-nine crop/activity/application rate combinations assessed

Day following treatment when MOE ≥ 100 (i.e., the REI)	0	1st	2nd	3rd	4th	5th	6th
Number of scenarios	6	3	8	5	4	2	1

  - Current REI under Worker Protection Standard (WPS) is 12 hours
  - Pre-harvest intervals for most malathion-treated crops range from 0 to 14 days, with majority at 7 days

Residential Handler Assessment

- Residential handler risk assessment factors
  - Activity (i.e., mixing/loading and application of pesticide)
  - Formulation (e.g., wettable powder, emulsifiable concentrate)
  - Application equipment (e.g., low pressure handwand)
  - Amount of pesticide handled (i.e., application rate area, treated)
  - Toxicity endpoint and uncertainty factors

Residential Handler Assessment

- Scenarios assessed
  - Various combinations of these factors (i.e., formulations, equipment types, maximum application rates for major use sites) result in 22 handler scenarios in the assessment, including:

    Mixing, loading and application of liquids with hose-end sprayers, backpack sprayers and low-pressure handwands

    Use of outdoor fogger

    Dust application using a shaker can

Residential Handler Assessment

- Data sources
  - Labels
  - EPA guidances and policies (e.g., OPP Draft SOPs for Residential Exposure Assessment)
  - Use information

Residential Handler Assessment

- Exposure and risk calculations

$$\text{Dose (mg/kg/day)} = \frac{\text{(Unit exposure) x (Use rate) x (Area treated per day)}}{\text{Body Weight}}$$

$$\text{MOE} = \frac{\text{NOAEL (mg/kg/day)}}{\text{Dose (mg/kg/day)}}$$

To reach target, must be ≥100

- Assessed short-/intermediate-term dermal and inhalation exposures

Residential Handler Assessment

- Summary of MOEs for handler scenarios
  - 95% (21/22) of scenarios reached the target MOE at baseline (i.e., short-sleeved shirt, short pants, no gloves)
  - Applying liquids with a low pressure handwand to control mosquitoes resulted in an MOE of 45

Residential Postapplication Assessment

- Scenarios assessed
  - Adult dermal exposure to residues following treatment of turf, vegetable gardens, ornamentals and “You-pick” crops
  - Toddler dermal, hand-to-mouth, turfgrass ingestion, and soil ingestion following turf treatment

Residential Postapplication Assessment

- Summary of postapplication risks
  - MOEs for all scenarios are ≥100, except

    Dermal exposure to toddlers following turfgrass treatment for both

    – commercial (MOE = 60) and

    – residential (MOE = 63).

Public Health Mosquito Control

Residential Postapplication

- Residential postapplication scenarios assessed
  - Adult dermal exposure to residues on turf following ground-based fogger and aerial ultra-low volume application for mosquito control
  - Toddler dermal, hand-to-mouth, turfgrass ingestion, and soil ingestion following ground-based fogger and aerial ultra-low volume application for mosquito control

Public Health Mosquito Control

Residential Postapplication

- Scenarios
  - Adult and toddler inhalation exposure following ground-based fogger and aerial ultra-low application for mosquito control
  - Adult and toddler combined inhalation and dermal exposure to residues on turf following ground-based fogger and aerial ultra-low application for mosquito control

Public Health Mosquito Control

Residential Postapplication

- Data sources
  - Published literature
  - AgDRIFT spray model

Public Health Mosquito Control

Residential Postapplication

- Published literature
  - Studies by Moore et al. (1993) and Tietze et al. (1994) using ultra-low volume cold aerosol generators

    Measured downwind deposition rate

    Determined a deposition rate of five percent for ground-based foggers

Public Health Mosquito Control

Residential Postapplication

- AgDRIFT spray model
  - Data similar to that for ground applications were not available for the aerial deposition
  - To calculate deposition from aerial ultra-low volume applications, HED used AgDRIFT (V 1.03; June 1997)
  - Model developed as a result of the efforts of the Spray Drift Task Force (SDTF), a coalition of 38 pesticide registrants, EPA and USDA
  - AgDRIFT predicts the motion of spray material released from aircraft

Public Health Mosquito Control

Residential Postapplication

- AgDRIFT spray model
  - AgDRIFT has extensive validation
  - Variety of useful outputs, including what percentage of the application volume remained aloft and what percentage of the resulting droplets deposited on the surfaces in the treatment area as well as downwind from the treatment area
  - For aerial ultra-low volume mosquito control, EPA determined that in the area of concern (i.e., from the edge of the treatment area to 1000 feet downwind), approximately 35 percent of the theoretical application is deposited

Public Health Mosquito Control

❖Results Residential Postapplication

Location	Dermal	Hand-to-Mouth	Turfgrass Ingestion	Soil Ingestion	Inhalation	Combined Dermal/ Inhalation
Adult MOEs						
Ground	150,000	--	--	--	26,000	22,000
Aerial	10,000	--	--	--	13,000	5,600
Toddler MOEs						
Ground	90,000	29,000	38 M	17 M	8,600	7,700
Aerial	5,000	15,000	2.5 M	13 M	3,800	2,200

- MOEs for all scenarios are greater than the required target MOE of 100

USDA Boll Weevil Eradication

- Systematic program to eliminate the boll weevil
- Accounts for large percentage of malathion use
- Assessed
  - Exposure to individuals living adjacent to treated-cotton areas

USDA Boll Weevil Eradication

- Residential Postapplication Scenarios Assessed
  - Adult dermal exposure to residues on turf following aerial ultra-low volume (ULV) application for boll weevil control
  - Toddler dermal, hand-to-mouth, turfgrass ingestion, and soil ingestion following aerial ULV application for boll weevil control
  - Adult and toddler inhalation exposure following aerial ULV application for boll weevil
  - Adult and toddler combined inhalation and dermal exposure to residues on turf following aerial ULV application for boll weevil

USDA Boll Weevil Eradication

- Residential postapplication
- Data sources
  - Labels
  - EPA guidances and policies (e.g., OPP Draft SOPs for Residential Exposure Assessment)
  - USDA Boll Weevil Eradication Program
  - AgDRIFT spray model

USDA Boll Weevil Eradication

- Results:

Population	Dermal	Hand-to-Mouth	Turfgrass Ingestion	Soil Ingestion	Inhalation	Combined Dermal/ Inhalation
MOEs						
Adults	2300	--	--	--	7600	1800
Toddlers	1400	4500	600,000	3M	2600	900

❖MOEs for all scenarios are greater than the required target MOE of 100

Human Health Malathion Incident Reports

Source: California 1982-1998

- 632 cases involving malathion (ag & non-ag)
  - 165 of these cases involved malathion + secondary chemical
  - 467 involved primarily malathion
- Non-agricultural (84%)
  - 28% due to inadequate packaging
  - Relatively mild symptoms related to noxious odor; not cholinergic poisoning
  - Serious cases represent small proportion – mostly accidental drenching and suicide attempts

Malathion Incident Reports

Source: California 1982 - 1998

- Agricultural
  - Cases tend to be more serious than non-agricultural incidents
  - Leading causes: hand application, equipment failure, improper dilution, failure to wear PPE

Malathion Incident Reports

Source: Poison Control Centers 1993 - 1998

- Reported illnesses:
  - Occupational (238)
  - Non-occupational (total)

    1,782 adults/older children

    221 children <6 years old

Malathion Incident Reports

Source: Poison Control Centers 1993 - 1996

- Symptomatic cases (1993-96) per estimated million containers in US homes for all insecticides:
  - For adults, rate was about 30% lower than for other insecticides
  - For children younger than six years of age, rate was about 68% lower

Human Health Risk Assessment: Aggregate Risk Assessments

Paula A. Deschamp, Risk Assessor
Health Effects Division

Aggregate Risk Assessment

- Includes exposure from various sources
  - Food
  - Drinking water
  - Residential and recreational site uses (bystander)
    - Public health use as a mosquito adulticide
    - Spray drift from Boll Weevil Eradication Uses
- Both adults and children considered

Aggregate Risk Assessment

- Acute aggregate
  - Food and water
- Chronic aggregate
  - Food and water
- Short-term aggregate
  - Food and water
  - Residential
    - Dermal
    - Inhalation

Aggregate Risk Assessment

- Acute aggregate risk does not exceed level of concern
  - Food – unrefined
  - Water – unrefined
- Chronic aggregate risk does not exceed level of concern
  - Food – highly refined
  - Water – unrefined

Aggregate Risk Assessment

- Short-term aggregate
  - Does not include home & garden use scenarios because of risk concerns
  - Does include residential/recreational bystander scenarios
  - Aggregate MOEs are >100 and not of risk concern

    Food + water + residential/recreational
    - Public health use as a mosquito adulticide
    - Spray drift from Boll Weevil Eradication Uses

Alternative View

Dr. Brian Dementi, Toxicologist
Health Effects Division

Ecological Risk Assessment

Environmental Chemistry & Fate in the Environment

Presented by: Norman Birchfield, Biologist
Brian Montague, Biologist
Environmental Fate and Effects Division

Chemistry and Fate in the Environment

Norman Birchfield, Biologist
Environmental Fate and Effects Division

Goals of Environmental Fate Assessment

- Where does malathion go in the environment?
- What organisms will be exposed and at what level?
  - Analyze malathion chemical properties and mode of action
  - Analyze persistence and mobility of malathion and important degradates in the environment
  - Characterize and estimate exposures

Malathion Issues

- Use sites
  - Urban
  - Agricultural
- Mechanisms of transport
  - Runoff
  - Spray drift
- Degradation products and toxicity
  - Hydrolysis products
  - Malaoxon

Quantifying Persistence

Laboratory Fate Data

- Aerobic soil half-lives range from 0.2 to 7 days
  - Microbial activity, moisture, organic content, and pH
- Anaerobic soil half-life: 2.5 days
- Breakdown in light (photolysis)
  - On soil: half-life 173 days
  - In water: half-life 156 days
- Binds moderately to soil

Quantifying Persistence

Laboratory Fate Data

- Aerobic aquatic half-life: 1.1 days
- Breakdown by water (hydrolysis)
  - Half-life 6 hours (alkaline conditions)
  - Half-life 6 days (neutral conditions)
  - Half-life 107 days (acidic conditions)
- Little bioaccumulation in fish
  - 4x to 200x increase of malathion in fish tissues
  - Residues in tissues decline rapidly in clean water

Degradates

- Hydrolysis products (lower toxicity)
  - Mono- and dicarboxylic acids
  - Demethyl degradates
- Malaoxon (increased toxicity)
  - Very low concentrations or no detections under conditions which favor malathion degradation
  - Noted to occur on man-made surfaces
  - Likely to be similar to malathion in persistence but data are lacking

Environmental Conditions and Malaoxon Production

- Increases malaoxon:
  - Dry
  - Exposure to air
  - Chlorine-containing water
    - Drinking water treatment
    - Swimming pools
- Reduces malaoxon:
  - Wet or moist
  - Microbial activity
  - Alkaline (high pH)

Major Monitoring Studies

1. Agricultural environment
   - Boll Weevil Eradication Program (USDA)
     - Nationwide eradication of major cotton pest
     - Major use of malathion
2. Urban environment
   - Non-native fruit fly eradication (USDA)
     - Eradication/control of regional outbreaks
     - Associated with reported fish kills reported

Major Monitoring Studies

3. Urban and agricultural
   - National Water Quality Assessment (NAWQA) - USGS
     - National assessment of streams
     - Grouped by land use
       - Urban
       - Agricultural

Monitoring Studies

Agricultural Environment

- The Boll Weevil Eradication Program uses aerially applied ultra-low volume malathion
- The program measured the following:
  - Malathion concentrations in runoff water
  - Off-site deposition levels from spray drift
  - Malathion concentrations in nearby water bodies before and after applications
  - Malaoxon levels in water near applications

Monitoring Studies

Agricultural Environment

- Measured low runoff levels from cotton fields (conditions favor degradation)
- Ultra-low volume formulations applied aerially result in higher drift than other formulations
- Measured low contamination levels in nearby streams, rivers, and ponds
  - Most concentrations below toxicity levels
- Little or no malaoxon detected

Monitoring Studies

Urban Environment

- Residential areas are sprayed from high altitude with a bait-malathion solution
- USDA measured
  - Malathion deposition and persistence on the ground
  - Malathion concentrations in storm water runoff and streams
  - Malaoxon levels in water and the ground

Monitoring Studies

Urban Environment Results

- Malathion in the urban environment is more prone to convert to malaoxon
- Multiple applications of malathion in the residential environment can lead to an accumulation of residues (in the absence of rain)
- Malathion/malaoxon on man-made surfaces can runoff and concentrate in storm water

Monitoring Studies

Urban and Agricultural Environments

- Assessment of streams across the United States
- Residues result from aggregate use
- Urban and agricultural land use areas included in the program

Monitoring Studies

Urban and Agricultural Environments

- Malathion detected in all types of water
- Commonly detected in urban streams
  - Highest levels found in urban streams
- Less commonly detected in agricultural streams
  - Lower levels detected in agricultural streams

Fate and Transport Summary

- Fate
  - Malathion degrades quickly under most moist conditions
  - Malaoxon slowly accumulates under some dry conditions
- Transport
  - Malathion and malaoxon in the urban environment are susceptible to runoff
  - Aerial applications of ultra-low volume formulations result in higher spray drift

Ecological Risk Assessment

Brian Montague, Biologist
Environmental Fate and Effects Division

Ecological Risk Assessment: (Deterministic)

- Exposure estimates are compared to ecological toxicity to determine potential for effects
- Calculate risk quotient: $\frac{EEC}{TOX} = RQ$
- Level of Concern (LOC)=the RQ levels we do not wish to exceed
- RQ > LOC suggests potential risk
- LOCs intentionally conservative (account for wide ranges of sensitivity among species)

Risk Characterization

- Refines the deterministic assessment
  - Further characterizes the exposure levels and likelihood of exposure to non-target organisms
  - Considers more information on fate and potential exposure from usage patterns
  - Compares exposure estimates to field study and actually monitored residue data
  - More in depth analysis of the natural history and behavior of potentially exposed organisms
  - Incident data compared to predicted effects

Toxicity to Terrestrial Organisms

- Birds
  - Acutely malathion is only slightly toxic from dietary ingestion
  - Malathion does display chronic effects to birds
    - Regressed ovaries and reduced egghatch beginning at levels equivalent to applications of over 2 lbs ai/acre
    - Reduction in adult body weight, egg viability, and embryo survival at levels equivalent to multi-application peak levels
- Reptiles
  - Low acute toxicity observed for Carolina anoles with LD_{50}=2324 mg ai/Kg

Toxicity to Terrestrial Organisms

- Mammals
  - Malathion is slightly toxic to mammals
- Non-Target Insects
  - Malathion is highly toxic to bees (LD_{50}=0.2 µg ai/bee) and other beneficial species from direct contact to spray or after contact with treated foliage
  - Malathion is highly toxic to insects with aquatic larval stages (LC_{50}=1 to 5 ppb)

Terrestrial Risk Overview

Based on screening level assessment the Agency concludes

- Likelihood of acute toxicity to birds, mammals and reptiles is low for most application scenarios
- There is concern for chronic effects to birds exposed to single applications at over 2 lb/ai/A and at lower rates with repeated pulse exposures with short intervals from multiple applications
- Small mammals may be sublethally affected, but at highest application rates only

Terrestrial Risk (Field Studies)

- Sublethal effects to birds observed in actual field usage of malathion have included slight reductions in neural activity (reduced acetylcholinesterase levels).

Toxicity to Fish and Amphibians

- Freshwater and marine fish toxicity
- Acute toxicity
  - Malathion is very highly toxic to most tested fish species and moderately toxic to others (LC50 range= 4 to 10,000 ppb)
  - Reproductive and chronic effects to fish
    - Reduction in number of young for trout at <44 ppb
    - Other observed chronic effects – spinal deformation, neural inhibition, disorientation, loss of avoidance response (various species)
- Amphibian Toxicity
  - Highly toxic to frog tadpole stages (LC_{50}=200 ppb)
  - Chronic Effects Frogs : > 1 ppm spinal deformation observed

Toxicity to Aquatic Invertebrates

- Toxicity to freshwater and estuarine invertebrates
  - Very highly toxic to most tested species with LC_{50} range of 0.5 to 180 ppb
    - Less toxic to adult oyster EC_{50}=2960 ppb
  - Reproductive effects at very low levels
    - Reduction in number of young at < 0.1 ppb
    - Mudcrab larvae reduced survival at < 20 ppb

Aquatic Risk Overview

Based on predicted and sometimes monitored environmental concentrations

- Acute risk potential exists for
  - Aquatic invertebrates (predicted at all application rates)
  - Sensitive fish (predicted at rates above 0.6 lbs ai/acre)
- Chronic risk potential exists for
  - Aquatic invertebrates (predicted for all labeled rates)
  - Fish in some scenarios (predicted at rates above 5 lbs/acre)
  - Chronic effects possible for amphibians at high rates

Aquatic Risk Overview

Field monitoring data considered

- Risk potential supported by field studies and monitoring data
  - Measured residues often exceed acute toxicity levels for aquatic invertebrates, but exceed less often for fish
  - Monitoring indicates adverse effects from malathion
- Field observations from public health uses
  - The Agency has reviewed many studies where adverse effects to aquatic organisms were observed after exposure to field applications of malathion at labeled rates

Ecological Incidents

- Many aquatic incidents reported
  - Wide variety of species affected
    - Fish (usually large numbers killed) often, but not exclusively, near urban areas
    - Invertebrates (appear largely unobserved though measured residues exceeded acute toxicity levels in many instances)
    - Some reports of amphibian mortality (frogs)
    - Some bee kills reported with alfalfa use
  - Uses related to incident
    - Urban uses most frequently implicated (Mosquito control, Medfly, etc)
    - Agricultural Incidents - most incidents reported with cotton use

Risk Characterization

Malathion poses risks to a broad spectrum of aquatic, wildlife, and insect species

- Potentially high risk for fish and invertebrates
- Chronic concern to birds from repeated exposures
- Field studies showed
  - Exposures levels exceeding aquatic toxicity levels
  - Mortality to aquatic species from labeled use rates

Risk Summary & Suggested Mitigation

Patricia Moe, CRM
Special Review and Reregistration Division

Risk Summary & Suggested Mitigation

Dietary

- No risk of concern for food and drinking water

Risk Summary & Suggested Mitigation

Residential

- Most scenarios are not of risk concern
- Turf post-application risk to toddlers
- Residential applicator risk (handwand)

- Mitigation Suggestions
  - Decrease turf application rates
  - Eliminate the use of handwand for turf
  - Delete residential turf use

Risk Summary & Suggested Mitigation

Occupational

- Some worker scenarios are of concern
- Existing restricted entry intervals of 12 hours are of concern for most crops
- Suggested mitigation
  - Increase levels of PPE and engineering controls as needed
  - Increase REIs for most crops (table provided in handout)

Risk Summary & Suggested Mitigation

Ecological

- Some risks of concern, primarily to aquatic species
- Possible mitigation
  - Buffer zones
  - Lower application rates
  - Specify number of applications
  - Specify application intervals
  - Revise application methods

Risk Summary & Suggested Mitigation

Homeowner Concerns

- Potential risk due to accidental breakage or improper storage of product
- Suggested mitigation
  - Packaging material
  - Strengthen storage guidelines

Risk Summary & Suggested Mitigation

The following uses are not supported:

- All pet uses
- All livestock uses
- All indoor uses (except for some stored commodities and storage facilities, and mushroom houses)
- All greenhouse uses
- All open-forest land uses
- All seed treatments

Risk Summary & Suggested Mitigation

The following uses are not supported:

- Almonds (including hulls and shells)
- Cranberries
- Filberts
- Peanuts (including forage, hay, storage and storage facilities)
- Peavines (including hay)
- Safflower seed
- Soybeans (including hay and forage)
- Sugar beets
- Sunflower seed
- Tobacco
- Treated raisin trays
- All pressurized can formulations

Risk Summary & Suggested Mitigation

Further data required

- Field trial data for apples, celery, flax
- Worker exposure data for root dip
- Worker exposure data for a power duster on stored grain commodities
- DFR and fate data

Next Steps

Lois Rossi, Director
Special Review and Reregistration Division
Office of Pesticide Programs

Phase 5

- Technical briefing
- Revised risk assessments available in the public docket and on the internet
- Begin 60-day public participation period
- Public can submit risk management ideas
- Opportunities for growers and others to meet with EPA

Next Steps

- 60-day public comment period
- E-mail comments to
  - **opp-docket@epa.gov**
- Mail comments to:

  U.S. EPA
  OP Pesticide Docket (7502C)
  401 M St., SW
  Washington, DC 20460

Next Steps

During Phase 6, the Agency will

- Review and consider all input received during the public comment period
- Formulate risk management decisions
- Prepare an IRED
- Conduct closure conference call

Contacts

- Michael Goodis (703) 308-8157
- E-mail: goodis.michael@epa.gov

Adjournment

Lois Rossi, Director

Special Review and Reregistration Division